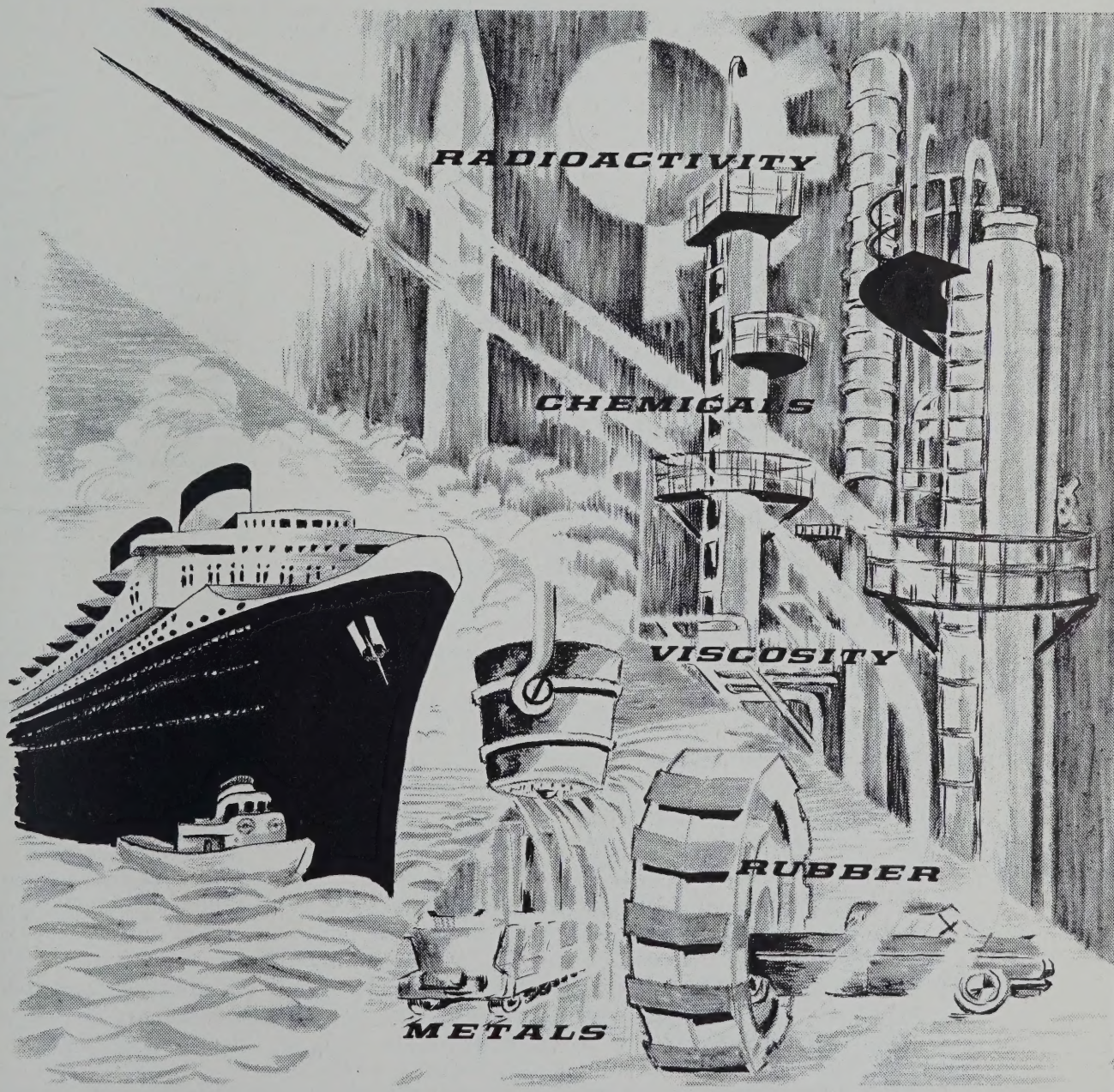
NATIONAL BUREAU OF STANDARDS September / 1965

Technical News Bulletin



U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

Technical News Bulletin

U.S. DEPARTMENT OF COMMERCE
John T. Connor, Secretary

NATIONAL BUREAU OF STANDARDS
A. V. Astin, Director

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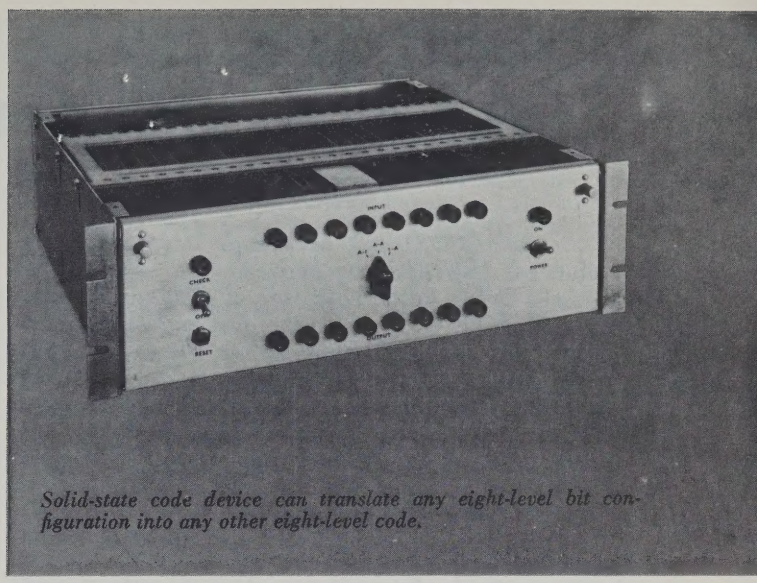
COVER: NBS standard reference materials, ranging from samples of metals and ceramics to color and radioactivity, directly support national efforts in science, technology, industry, and commerce. Through this activity more than 70,000 units of 600 kinds of materials are prepared, certified, and distributed. The wide range of technical and industrial interest in the standard reference materials program is reflected by the cover design, taken from the latest publication in a new NBS series devoted to such materials (see page 151).

Compact Code Translator for Computer Languages



Solid-state code device can translate any eight-level bit configuration into any other eight-level code.

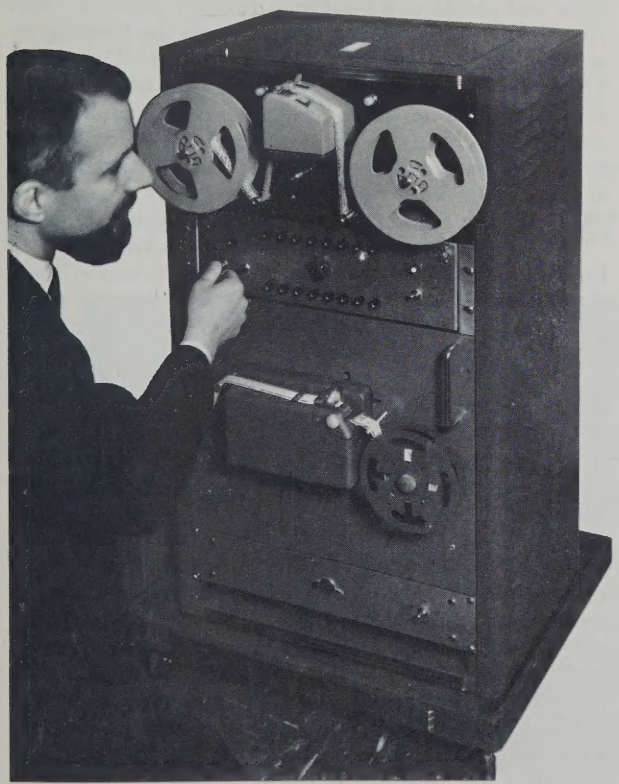
★ CODE TRANSLATION is often required between dissimilar makes of data processing and communications equipment because of the nonstandardized bit codes used by different manufacturers. A simple solid-state code translator has been developed by Charles H. Popenoe at the NBS Institute for Basic Standards. The device can translate any eight-level bit configuration into any other eight-level code and may be switched to perform the reverse translation. The entire translator is self-contained in a small cabinet (19 in. by 5 in. by 15 in.) and can operate independently of other equipment if necessary for checkout purposes.

The translation is accomplished by two interconnected diode matrices, each containing 400 silicon diodes wired for a particular coding on plug-in circuit boards. The individual matrices are functionally symmetrical; either matrix may be used as input or output, permitting bilateral translation with a single circuit rather than two. The reverse translation requires only a switched interchange of input and output connections.

In its present form, the translator is connected between a paper tape reader and a tape perforator so that the information is read from the first tape, translated, and simultaneously punched into the second tape in the new code. However, the device will perform code conversion between any two pieces of digital equipment which will accept input and output information in parallel bit form, such as magnetic tape or teletypewriters.

The device recognizes two different codings for 50 alphanumeric characters. Since the codes are wired into plug-in circuit boards, the translator may be quickly adapted to recognize any two alternate codes by simply plugging in the appropriate code boards. In a similar manner, more than 50 alphanumeric characters may be accommodated by the addition of supplementary code boards. Thus, the machine's vocabulary may be expanded or reduced to fit the user's requirements.

In the event that a bit configuration or character which is not in the present vocabulary is sensed at the translator input, either of two switched options will occur—a front panel indicator will light signifying that an improper character has been sensed at the input and the translation will continue, or the translating process will be immediately interrupted and will remain so until the operator pushes a reset button.



Charles Popenoe initiates the punch operation of the translator. The tape on the top spools is read and translated by the machine (below top spools) as another tape is simultaneously punched in a different computer code (bottom).

Additives Improve Roofing Asphalts

★ ACCORDING to a study at the NBS Institute for Applied Technology, superior roofing-grade asphalts can be produced by use of small quantities of selected additives. S. H. Greenfeld, a research associate of the Asphalt Roofing Industry Bureau at NBS, investigated the effects of oils, acids, and polymers on air-blown asphalts. The results show that choice of an additive depends greatly on the asphalt used, as a particular additive may enhance the physical properties of some asphalts, may not effect others, and may have a detrimental effect on still others.

Asphalt is a residual product of petroleum distillation with a very high temperature coefficient of viscosity. As such it is generally usable only on relatively horizontal surfaces. However, about 70 years ago, controlled oxidation or "blowing" was found to improve the stability of asphalt and thus to make it suitable for use as a roofing material.

Nevertheless, blowing cannot correct all of the deficiences in asphalts, many of which seem to be related to the geographic sources of crude oils. Asphalts produced from some of these crudes (even by the best conventional methods) are too hard and brittle to withstand the extremes of temperature, solar radiation, and rainfall to which roofing is exposed. Previous studies [1, 2] have shown how better asphalts could be produced by modifying the blowing conditions. In cases where these modifications are not practical or not sufficient, additives may be of interest.

In the present study, four asphalt fluxes—California Coastal, Kansas, Talco, and Tia Juana—were used. The last three were obtained in both hard and soft grades. Soft grades are those that can be air blown to coating grade without modification; the California flux could be obtained only in the hard grade. The oils, acids, and polymers were added to the fluxes before blowing, and the mixtures were blown in both agitated and nonagitated stills at air flow rates of 75 ft^3 per ton-min and 150 ft^3 per ton-min.

As no general specification exists for coating-grade asphalts, individual asphalt producers determine narrow specifications suited to their needs. However, to provide a common reference base for this study, a hypothetical specification was drawn up that is broad enough to cover most individual specifications. (See table 1.)

TABLE 1. *Hypothetical coating-grade asphalt specification*

Property	Range
Softening point, °F	215–225
Penetration @ 32 °F, 1/10 mm	10 minimum
Penetration @ 77 °F, 1/10 mm	15–25
Penetration @ 115 °F, 1/10 mm	25–45

Fluxing Oils

Oil is one of the most readily available materials for use in reducing the hardness and brittleness of asphalts. In this study, four representative oils were evaluated as additives at 5 percent concentrations. The results were very irregular and obviously depended on the compositions of both the oils and the asphalts. All of the oils increased the penetrations for California, Kansas, and Tia Juana asphalts. Although the penetrations of Talco asphalts were unaffected, their durabilities were appreciably increased by the use of these fluxing oils. Durability results for other asphalts were less uniform. Western Reclaimed Lubricating Oil and Western Bright Stock improved the durabilities of California, Kansas, and Talco asphalts; Mid-Continent Bright Stock improved their durabilities somewhat less, and Eastern Reclaimed Lubricating Oil improved them least. None of the oils helped the durability of the Tia Juana asphalt.

Acids

Small quantities of acidic materials have been used quite effectively for many years to impart special properties to asphalts. Phosphoric acid increases penetrations and produces a somewhat rubbery product. Ferric chloride (a Lewis-type acid) speeds the blowing reactions and increases the fire resistance of asphalts. These and other acidic materials—including phytic acid, pyromellitic dianhydride, trimellitic anhydride, and VR–1 acids (residue of the production of sebacic acid from castor oil)—were investigated as additives at the 1 percent level. Each additive had a particular effect on each asphalt, as well as certain general effects.

The ferric chloride accelerated the blowing of all four fluxes regardless of agitation. Normally, these fluxes must be blown for 200–400 min without agitation, or 60–70 min with agitation, to produce a coating-grade asphalt. With ferric chloride, the time was reduced to 19–52 min without agitation, or 4–16 min with agitation. In addition, this additive improved all asphalt penetrations materially. However, it decreased the durabilities of the Kansas asphalts.

Phosphoric acid had mixed effects on blowing times, causing reductions as great as 40 percent and increases of less than 15 percent. This material increased the durabilities of California and Kansas asphalts, yet had little effect on Talco and Tia Juana asphalts. It increased the penetrations of California asphalts significantly more than did ferric chloride. Phytic acid produced results comparable to phosphoric acid in all respects.

The results obtained with the other three "catalysts" were less spectacular and quite mixed. The best performance was that of the trimellitic anhydride in Tia

Juana asphalt. This additive increased durability to 100 days as compared to 68 days for the unmodified flux blown under the same conditions.

Polymers

Many types of polymeric materials can be added to asphalt to produce specific effects. A number of these were added to the fluxes at 5 percent concentrations. An epoxy resin, added immediately after mixing with its catalyst, increased the blowing times and decreased the penetrations of the asphalts. The durabilities of the California asphalts increased appreciably; those of the Kansas asphalts increased slightly; and those of the Talco and Tia Juana asphalts decreased. Polychloroprene had little or no effect on any of the asphalts.

Silicone had very mixed effects on blowing times, ranging from slight decreases to increases of 100 percent. However, it always increased penetration, and in all but one instance it was detrimental to durability. The resulting asphalts were full of finely dispersed particles of silicone.

Poly (vinyl butral), poly (vinyl formal), and polyvinylidene chloride latex were evaluated only in the California flux. All these additives tended to increase blowing times. Both vinyl polymers had little effect on penetration, but increased durability appreciably. The polyvinylidene chloride latex increased the penetrations, but decreased durability.

The additives and blowing conditions most beneficial in terms of durability of the end product are listed in table 2.

[1] The effect of blowing variables on the durability of coating grade asphalts, *by S. H. Greenfeld, Ind. Eng. Chem. Prod. Res. Dev.* **3**, *No. 2 (June 1964); also,* Effect of blowing conditions on asphalt durability and blowing time, *NBS Tech. News Bull.* **48**, *No. 6, 94 (June 1964).*

[2] Ozonation of asphalt flux, *by P. G. Campbell and J. R. Wright, Ind. Eng. Chem. Prod. Res. Dev.* **3**, *No. 3, 186–194 (September 1964);* also Oxygen and ozone improve asphalt durability, *NBS Tech. News Bull.* **49**, *No. 2 (February 1965).*

TABLE 2. *Asphalts, additives, and durabilities*

Flux	Additive	Concentration	Blowing condition	Durability	
				With additive	Without additive
		Percent		*Days*	*Days*
California	Poly (vinyl butral)	5	B	100	44
California	Poly (vinyl formal)	5	B	96	44
Kansas	Phytic acid	1	A	110	65
Kansas	Phytic acid	1	B	107	81
Talco	Western Reclaimed Lube.	5	A	86	56
Talco	Western Bright Stock	5	A	84	56
Talco	Mid-Continent Bright Stock.	5	B	83	48
Tia Juana	Trimellitic anhydride	1	A	100	60

A = 475 °F, 0 rpm, 150 ft³/ton-min.
B = 475 °F, 1400 rpm, 75 ft³/ton-min.

Astin Receives ASTM Executive Award

ON JUNE 16, 1965, NBS Director A. V. Astin (left) received the fourth American Society for Testing and Materials Award to Executives from the Society's president, Charles L. Kent. Presented at the Society's annual meeting held at Purdue University, Lafayette, Ind., the award "honors an executive who, through his outstanding interest and support, has furthered the accomplishments of ASTM."

Overwater Microwave Propagation

★ RADIO SCIENTISTS of the NBS Central Radio Propagation Laboratory have measured certain characteristics of microwave radio signals transmitted over water at the Eleuthera Island portion of the Atlantic Missile Range Mistram tracking system.[1] The Air Force had asked CRPL to obtain information on relative variations in phase and amplitude at two microwave frequencies. The findings will aid in appraising the stability of overwater microwave links.

The microwave system studied at Eleuthera Island, in the Bahamas, is an essential part of the Mistram precision missile trajectory measurement system, since it transmits phase information to a central station for conversion to target position and velocity information. The accuracy of the tracking system depends in part on the phase and amplitude stability of these transmissions. Changes in phase and amplitude occur when a signal encounters spatial and temporal variations in the three-dimensional structure of the atmospheric refractive index along its path.

The Bureau made propagation measurements at two stations, one at each end of a 47-km (29½-mile) overwater microwave link on Eleuthera Island. One of the terminals is a central station using a 3-m parabolic reflector mounted 32 m above sea level to communicate at 9.2 and 9.4 GHz. The other station is the Powell Point terminal; it has a 2.4-m dish located 71 m above sea level. The signal-mixing circuitry at these installations was placed as close to the antennas as possible, directly behind the reflector at Powell Point. At the central site the circuitry and antenna were connected by 20 m of waveguide, however, which ran through an air-conditioned building and should therefore contribute no instabilities. Hence virtually all of the phase and amplitude variations recorded were contributed by the propagation medium and (to a very small extent) by mechanical motion of the antenna mounting systems.

The radio refractive index of the atmosphere was measured at both stations by means of microwave refractometers [2] near the antennas. The readings of wet- and dry-bulb thermometers, aneroid barometers, and anemometers also were recorded at both stations during the phase and amplitude variation measurements. The radio refractive index was known at both stations, directly from the refractometers and by computation from the air temperature, relative humidity (obtained from the wet- and dry-bulb temperatures), and the atmospheric pressure.

Measurements were made of simultaneous reception at 9.2 and 9.4 GHz for three periods, each approximately two days long. The phase of each signal was, in effect, compared with an arbitrary reference of the same frequency at the receiving site. The phase variation signal at each frequency was split into two components for recording on magnetic tape, one consisting of fluctuation frequencies from 0 to 10 Hz and the other from 0.25 to 10 Hz. This technique was used to obtain high resolution and long-term continuity. The difference between the phase shifts of the 9.2- and 9.4-GHz signals also was recorded, likewise by means of a two-band technique.

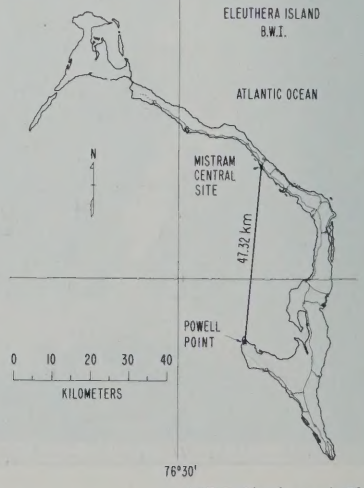
The phase variations at the two radio frequencies were found to be well correlated with each other for very low fluctuation frequencies, but this correlation decreased with increasing fluctuation frequency, and became essentially zero above 1 Hz. Study of the speed and extent of phase shifts showed that during virtually all of the sample periods (3-min intervals) the phase difference varied more than 5°. Changes of the order of 20° sometimes occurred within 1 sec. The variation of phase difference showed no correlation with time of day, tide, atmospheric refractivity, or wind data.

Observation of fading conditions disclosed that the amplitude at each frequency varied widely and that a 10 dB change in difference between the amplitude shifts at the two frequencies can occur within 1 min. The probability is 0.17 that the differential amplitude will vary more than 10 dB within any half hour. As in the case of the phase data, the differential amplitudes showed no correlation with the meteorological conditions recorded.

The role played by sea reflection was investigated by placing a specially designed screen at the nominal sea reflection point to eliminate multipath interference from sea reflections. This failed to produce any clearly identifiable effect on the fading data.

[1] *More detailed results of this study are presented in NBS Tech. Note 307,* Phase and Amplitude Diversity in Over-Water Transmissions at Two Microwave Frequencies, *by H. B. Janes, A. W. Kirkpatrick, D. M. Waters, and D. Smith, available at a cost of 40 cents from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402.*

[2] *For further information about microwave refractometers, see* Radio refractometry applied to humidity measurements, *NBS Tech. News Bull.* **47,** *125–126 (July 1963).*



The hook shape of Eleuthera Island, one of the Bahama Islands forming part of the Atlantic Missile Range, was used to advantage to obtain an overwater radio path for determining the effects on a radio signal transmitted over water.

AUTO SEAT BELT STANDARDS REVISED

★ IN APRIL proposed changes were published for the auto seat belt standards first announced by the Department of Commerce last December. With slight revision these changes have now been incorporated in the standards; in this form the standards become mandatory on December 31, 1965. Beginning on that day, the manufacture, sale, or transportation in interstate commerce of seat belts which do not meet the revised standards will be unlawful. The standards with the revisions were printed in the July 1, 1965 *Federal Register*.

The original standards, published in the December 11, 1964 *Federal Register*, become effective on that same date in 1965. The revisions based on the changes proposed in April do not become effective until the end of the year.

The most significant additions proposed in April pertain to nonferrous corrosion of hardware, fracture of hardware, and performance of belt retractors in a dusty environment. Slight revision of the proposed changes was based on letters received as a result of the April announcement, and served to clarify minor points. A dynamic test simultating collision will be considered for possible inclusion in the standards at a later time.

Public Law 88–201, approved by the Congress on December 13, 1963, required the Department of Commerce to issue standards "to provide the public with safe seat belts so that passenger injuries in motor vehicle accidents can be kept to a minimum." The seat belt standards were developed by the National Bureau of Standards in consultation with the Society of Automotive Engineers and an ad hoc committee of representatives of interested Federal Agencies.

The standards cover three types of seat belt assemblies: a lap belt, a safety harness for adults, and a safety harness for children. The lap belt provides restraint only on the pelvis and is designed for situations where movement of the upper part of the body is not likely to cause injury. The safety harness provides restraint both on the pelvis and the upper torso and is designed for situations where movement of the entire body must be restricted to avoid injury. The standards permit the safety harness for adults to be either an integral harness or a combination of lap and shoulder belts.

NBS installs

Infrasonic Station at Tel-Aviv

★ A STATION for the detection of inaudible sound waves, such as result from earthquakes and other large-scale geophysical disturbances, has been installed near Tel-Aviv, Israel, by the Bureau. Very-low-frequency sound-wave data obtained from the new infrasonic station will supplement data from the Bureau's two other infrasonic stations in Washington, D.C., and Boulder, Colo. These stations provide information on the paths of tornadic disturbances in the atmosphere, and on the physics of the upper atmosphere, especially with respect to the sun's effect on the earth's magnetic field. Most of the equipment for the new station is on loan from NBS to the Standards Institution of Israel, whose staff will operate the station with U.S. counterpart funds.

Although the atmosphere may sometimes seem relatively free from audible sounds, natural sounds of substantial intensity are always present. These sounds are propagated through the atmosphere at infrasonic frequencies—frequenices lower than the human auditory threshold of about 15 Hz. At very low frequencies, sound waves are dissipated only slightly by absorption and thus can be propagated over great distances.

One of the first natural sounds observed at great distances resulted in 1883 from a tremendous explosion of the volcano Krakatoa in the East Indies. At this time, electronic equipment suitable for detection of such waves did not exist, but inaudible sound waves from this disturbance traveled around the world several times with sound pressures so great that readable deflections were produced on barographs.

Each of the NBS infrasonic stations consists essentially of four microphones, located several miles apart, and connected to a central laboratory. The microphones produce frequency-modulated voltages proportional to the incident sound pressures. These voltages are transmitted by telephone wire to the central laboratory, where they are demodulated, amplified, and recorded as ink-on-paper traces. When a sound wave of sufficient magnitude is present, similar traces are produced on each of the four paper records. The direction of approach of the wave and the trace velocity are obtained by comparing the different times of arrival at the four microphones.[1]

Preliminary data from the Tel-Aviv station seem to show that microbarom waves (regular, sinusoidal VLF sound waves having a period of about 6 seconds), common in Washington, D.C., are also present in the Middle East. It is expected that data obtained from the new station will help to determine the origin of certain other VLF sound waves which approach North America from the direction of the South Atlantic Ocean, and from the Auroral Zone. The waves from the Auroral Zone may be caused by gross ionospheric motions.

[1] Unusual recordings of infrasonic disturbances in the atmosphere, *NBS Tech. News Bull.* **44**, *206 (Dec. 1960)*.

Dr. I. H. Usmani shakes hands with U.S. Ambassador Walter P. McConaughy (left) while receiving a check of Rs. 52,500. Others in the front row are Mr. John M. Tinker, Science Attaché of the American Embassy (second from right), and Mr. A. S. F. Salahuddin, Finance Member of the Commission.

Foreign Currency Scientific Program Supplements NBS Research

★ A RECENT RESEARCH grant to the Pakistan Atomic Energy Commission emphasizes the importance of the Bureau's Foreign-Currency Program, according to Dr. L. L. Marton, NBS Coordinator of Special International Programs. The project is one of 46 active NBS-sponsored research projects financed by the accumulation of foreign funds in certain countries participating in the U.S. Agricultural Aid Program.

The Pakistan project is progressing satisfactorily on schedule, says Dr. James R. DeVoe, NBS Institute for Materials Research, and Technical Monitor of the project. The work is designed to devise new, more rapid methods of making radiochemical separations by isotopic exchange.

In the 3½ years since the Program was instituted, the Bureau has been allotted a total of $2½ million of these foreign funds, enabling it to support technical projects in India, Israel, and Pakistan.

Each proposed project is evaluated on the basis of its contribution to the Bureau's mission and its general scientific merit, as well as its cost in relation to Program funds then available. Inherent in each grant is its potential contribution to one or more of the Bureau's basic needs, such as more accurate standards of measurement; compilation and measurement of critical data or standard reference data on physical constants and the properties of materials; or improved methods for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce.

The check for 52,500 rupees given this spring to Dr. I. H. Usmani, Chairman of the Pakistan Atomic Energy Commission, represents half the total grant for the Pakistan project. Funds have been made available to the Bureau annually since 1962, under a section of the Agricultural Trade Development and Assistance Act of 1954.

In his research to develop new techniques for achieving rapid radiochemical separation by isotopic exchange, Dr. Iqbal H. Qureshi, Senior Scientific Officer, Atomic Energy Center, Lahore, Pakistan, is studying isotopes of strontium, antimony, bismuth, and thallium.

Rapid radiochemical separations are needed for preparing radio isotopes for use in science and industry. There is a need today, says Dr. DeVoe, for the development of new techniques in this area which will be simple, rapid, and of general applicability in radiochemistry.

According to Dr. Marton, scientific groups pursuing these research projects in their own relatively underdeveloped countries extend the research capabilities of the Bureau, contribute to American industrial and scientific interests, and raise their own countries' technical levels.

Professor Henry Eisenberg, Weizmann Institute of Science, Rehovoth, Israel, whose project consists of a study of excluded volume in multicomponent polyelectrolyte systems, and who visited the Bureau recently to report on his work, represents a case in point. According to Dr. Donald McIntyre, NBS Institute for Materials Research, who serves as Technical Monitor of the project, the Bureau is well pleased with the results from this work. It finds that this, like several other projects, fits readily into the National Standard Reference Data System, which the Bureau administers, and which promotes and coordinates systematic data compilation and evaluation activities in all fields of the physical sciences.

Several of the earlier grants proved so fruitful that they were renewed or extended. At the end of fiscal '65, there were 23 active projects in Israel, 21 in India, and 2 in Pakistan.

The opportunity for the Bureau to participate in this Program arises from the Agricultural Trade Development and Assistance Act of 1954, which enables many foreign countries to buy U.S. agricultural products and pay in local currency.

As such foreign currency accumulates, the United States can use it for a variety of purposes, but only in the country in which it originates. In case of surplus over normal U.S. Government needs, Congress may authorize the use of some of the surplus for scientific purposes. Although NBS has been limited to three countries to date, it may later have an opportunity to grant research contracts in a few others.

Although not usually of a top priority nature at the time, the Program complements the work normally done by the Bureau. All studies represent work that NBS should be doing, and would ultimately have to do and pay for in dollars if foreign currency were not available. Since this research can be conducted now, the Bureau gets the advantage of top level scientific research which meets timely and definite needs.

TYPICAL DAYLIGHT EVALUATED

★ MANUFACTURED GOODS such as textiles, paints, plastics, paper, and ceramics depend largely on their color for customer acceptability. Hence, color appraisal and color control are important steps in the production of such goods. Lamp-and-filter combinations intended to be representative of typical daylight have long been used as light sources in this work. In recent years, however, these sources have been criticized for having insufficient ultraviolet content and for being too limited in their applications.

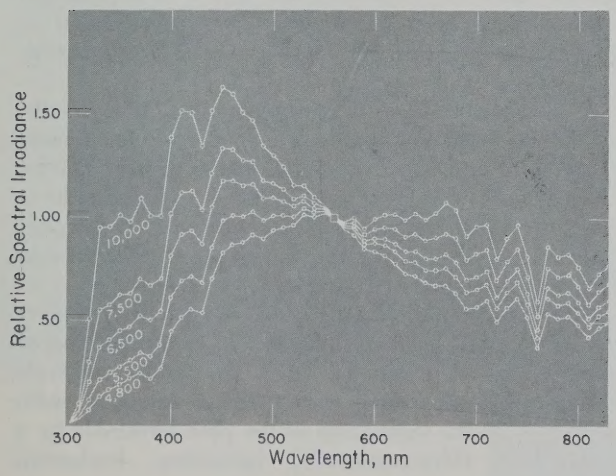
An evaluation of typical daylight was therefore undertaken simultaneously in three different countries recently. Laboratories in England, Canada, and the United States [1] utilized modern instrumentation to measure actual daylight energy in the ultraviolet and visible portions of the spectrum. The spectral distribution data thus derived were correlated with various color temperatures [2] by Deane B. Judd of the NBS Institute for Basic Standards, chairman of a national committee on colorimetry; David L. MacAdam,[3] a member of the committee; and Günter Wyszecki of the Canadian National Research Council. The resultant curves will be used to develop new light sources for international use in the color field.

In the preliminary work, a total of 622 spectral distributions were obtained: 274 in England, 99 in Canada, and 249 in this country. These distributions—a data compilation far more comprehensive than any previously derived—were subsequently assembled and evaluated by advanced statistical techniques (a characteristic-vector method). From the evaluation, spectral irradiance curves from 300 to 830 nm were computed for various phases of daylight that may be correlated with color temperatures from 4,000 °K (yellowish sunlight) to 40,000 °K (blue light from the clear sky). The graph shows five of these curves at correlated color temperatures of 4,800; 5,500; 6,500; 7,500; and 10,000 °K.[4]

These new "daylight" curves are now being used as targets by manufacturers of artificial daylighting equipment in efforts to produce new artificial daylight sources. Such sources might be combinations of incandescent lamps and blue filters with an ultraviolet lamp, or specially designed fluorescent lamps, or xenon-arc lamps with suitable filters. The new curves will also probably be recommended as standards for color rendering measurements of fluorescent lamps by the International Commission on Illumination at its next session in 1967.

It is anticipated that when new sources become available they will serve three distinct purposes: (1) For use in industrial inspections; (2) for visual and photoelectric colorimetry in the laboratory; and (3) for the reduction of spectrophotometric data to color specifications for raw materials and manufactured goods.

One of the new sources may have a correlated color temperature of 7,500 °K, corresponding to the color of lightly overcast blue sky, and favored in this country and Canada for industrial inspections. Another may be at 6,500 °K, corresponding to the color of a completely overcast sky, and favored in Great Britain—because it is typical of British daylight—for industrial inspections. Still another may be at 4,800 °K, corresponding to the color of the light from the sun at an angle of about 30 degrees above the horizon, for use in various kinds of colorimetry.



Spectral distributions of typical daylight for various correlated color temperatures. The curves were reconstituted from the mean and the first two characteristic vectors of 622 measured spectral distributions in England, Canada, and the United States.

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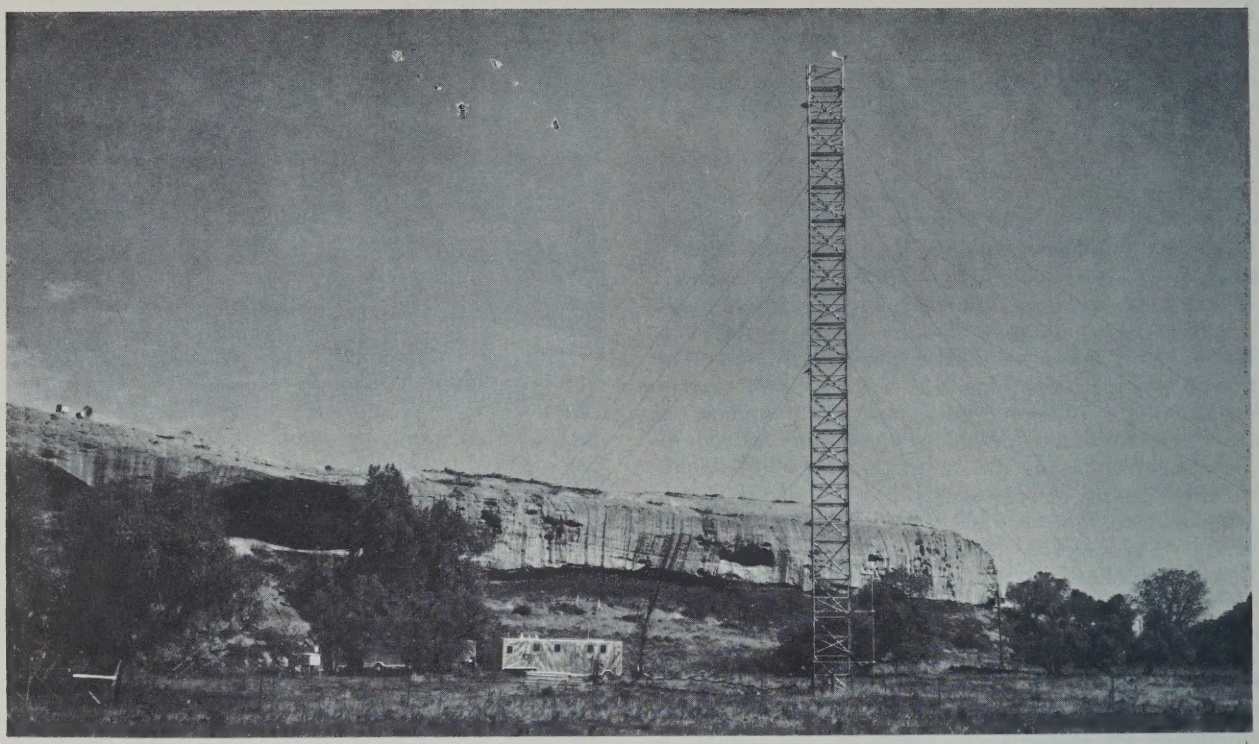
[1] *Facilities of the Thorne Electrical Industries, Enfield, England; the National Research Council, Ottawa, Canada; and the Eastman Kodak Company, Rochester, N.Y., respectively.*

[2] *Color temperature of a light source is the temperature of a blackbody radiator that has the same chromaticity (but in the case of daylight not the same spectral distribution) as that of the source. Color temperature serves indirectly to define artificial daylight sources.*

[3] *On the staff of the Eastman Kodak laboratory.*

[4] *For further details, see* Spectral distribution of typical daylight as a function of correlated color temperature, *by Deane B. Judd, David L. MacAdam, and Günter Wyszecki (with the collaboration of H. W. Budde, H. R. Condit, S. T. Henderson, and J. L. Simonds), J. Opt. Soc. Am.* **54,** *1031 (1964). (Note: Eastman Kodak Co. contributed the program and computer time for evaluating the characteristic vectors from which all the curves between 4,000 and 40,000 °K were computed.)*



Stability of Radio Paths

★ THE SHORT-TERM and long-term variations found in the apparent lengths of radio wave paths are of interest in designing missile tracking systems. Scientists of the NBS Central Radio Propagation Laboratory (Boulder, Colo.) measured the changes by phase comparison in a series of eight experiments over paths 713 m to 17.1 km (about ½ to 10½ miles). The variations resulted primarily from atmospheric changes. These experiments were conducted by the Bureau at field sites near Boulder and Cape Kennedy, Fla., in research performed in part for the Air Force.[1]

Variables of Radio Propagation

The velocity of electromagnetic waves in the earth's atmosphere fluctuates slightly from time to time and place to place. The velocity, usually expressed in terms of the path refractive index, can be measured or computed for a homogeneous path for which temperature, pressure, and relative humidity are known. Actual conditions are not that simple, however, because of atmospheric turbulence.[2] CRPL scientists measured fluctuations in velocity as variation in apparent path length, using a phase comparison technique.

Above: *This tower near Boulder, Colo., contains instruments for making meteorological measurements of horizontal wind velocity, insolation, barometric pressure, and wet- and dry-bulb temperatures. The data were used to seek correlations with variations in microwave signals transmitted over several test paths. One of the paths ends at the microwave reflector visible atop the bluff at left.*

Radio Paths Studied

Propagation variations were measured for varied conditions in five test runs near Boulder and three in the vicinity of the Air Force Missile Test Center at Cape Kennedy. Transmissions at 9.4 GHz over a 15.2-km path were used to evaluate effects of polarization and antenna beamwidth. The effects of ground reflections were studied by reception over a 713-m path using two vertically-separated antennas. Transmissions over a 3.2-km path were received by low antennas to determine the effects of reflections over a relatively long path. Lower frequencies were investigated by comparing reception of 100-MHz and 9.4-GHz signals on the same path.

The runs at Cape Kennedy supplied data for the climatic conditions under which the actual missile tracking systems operate. The effect of propagation over flat terrain at approximately grazing incidence with the foliage was studied by the use of antennas above, at, and below grazing incidence at the receiving ends of 7.7-km and 17.1-km paths.

The variations in each apparent path length were recorded over several days, for each run, on paper strip charts or magnetic tape. At regular intervals simultaneous recordings were made of values of radio refractive index (measured at the path terminals by a microwave refractometer[3]), insolation, horizontal

Announcing

NBS

PRECISION MEASUREMENT SEMINARS

1965-66

NBS Precision Measurement Seminars for 1965–66

In continuation of the program of Precision Measurement Seminars held at the National Bureau of Standards for the past two winters, a new group of topics is planned for 1965–66. The purpose is to present information on the problems of standards laboratories in measuring physical quantities and calibrating instruments primarily at levels of accuracy used at the Bureau in its calibration services. The program is a part of the Bureau's continuing effort to provide advice and assistance on measurement and calibration problems met by the growing number of standards laboratories serving either research or production activities in industry, the universities, and other government agencies.

The seminars are open to a limited number of persons from measurement and standards laboratories who meet appropriate prerequisites relating to education, work experience, and current professional activity. The sessions will include lectures and group discussions, supplemented by laboratory demonstrations. Seminars will last from 3 to 5 days and will be held either at the Washington or the Boulder (Colo.) laboratories of the Bureau, depending on the subject matter. The registration fees to be charged cover the estimated added cost to the Bureau.

Seminars will be offered in the following fields, provided the registration is sufficiently large in each:

Low Frequency Electrical Standards (W)**
Precision Thermometry Below 273°K (W)
Length Measurements (W)
Precision and Accuracy in Measurement and Calibration (W)
High Frequency and Microwave Noise (B)*
High Frequency and Microwave Field Strength (B)

Details presently available on each of these tentative seminars, and the application procedures for each, appear in the sections below:

Low Frequency Electrical Standards (W)

Brief Description: This 3-day seminar will cover the measurement methods used by NBS to establish and maintain the basic electrical units and to calibrate standards of resistance, inductance, capacitance, voltage, current and power from direct current up through 30 kilohertz. It will consist of lectures and demonstrations in the laboratories of the Electricity Division in Washington, D.C. Emphasis will be on measurement techniques which are likely to be most useful to those in high-grade standards laboratories.

Prerequisites: Candidates must have undergraduate college-level training in physics or electrical engineering and must be currently engaged in professional work in precise electrical measurements, at a level involving the basic reference standards of a calibration or standards laboratory. Preference will be given to those whose position involves the training of others in precise electrical measurements.

Arrangements: Attendance will be limited to 50 people, who will be divided into subgroups for the laboratory demonstrations. Fee, $50. Tentative dates: December 8–10, 1965. Apply to F. L. Hermach, Electricity Division, National Bureau of Standards, Washington, D.C. 20234.

Precision Thermometry Below 273°K (W)

Brief Description: Both the primary temperature scales from 273°K down to absolute zero and the practical methods of secondary thermometry will be presented. The three major areas are:

a. Theory and thermometry associated with platinum resistance devices for 273°K to 14°K.

**(W) indicates seminar to be held at Washington, D.C.
*(B) indicates seminar to be held at Boulder, Colorado.

b. Thermometry below 20 °K with temperatures derived from the NBS acoustic thermometer and germanium resistance thermometers.

c. Thermocouples used in cryogenic engineering.

Prerequisites: Candidates must have undergraduate college-level training in engineering or physics, and must be currently engaged at a professional level in precision measurements of temperature.

Arrangements: Attendance will be limited to 30 people. Fee, $75. Tentative dates: January 11–13, 1966. Apply to Dr. Harmon Plumb, Heat Division, National Bureau of Standards, Washington, D.C., 20234.

Length Measurements (W)

Brief Description: Topics to be covered include interferometric absolute length determination: particular attention given to light sources; wringing interval; aperture, phase, and ambient corrections; application to gage block and meter length calibration. Interferometric methods of calibration of flatness, surface finish, diameter, and length comparison are covered. Optical and mechanical methods of dimensional metrology as applied to length, angle profile, surface finish; deformation, contact pressure, elastic limit are given special attention. Experimental and statistical programs for determination of systematic, random, and instrumental error are discussed. Theoretical development will be supplemented with laboratory demonstration.

Prerequisites: Candidates must have undergraduate college level training in engineering or physics and must be currently engaged at a professional level in precise dimensional metrology. Preparation should include review of NBS Handbook 77, Vol. III, pp. 1–350; physical optics, e.g., Ditchburn, *Light*, ch. I–V, VIII, IX, XIII, XIV; engineering optics; e.g., Habell and Cox, *Engineering Optics*, ch. IV–VIII.

Arrangements: Group will be limited to 20, selected on basis of academic qualification and experience. Fee, $150. Tentative dates: February 7–11, 1966. Apply to T. R. Young, Metrology Division, National Bureau of Standards, Washington, D.C., 20234.

Precision and Accuracy in Measurement and Calibration (W)

Brief Description: Measurement—qualitative and quantitative aspects. Errors, residuals, precision, accuracy. Quality control of a measurement process, control charts. Measurement of the precision and assessment of the accuracy of a measurement process. Expression of the uncertainties affecting a measurement value. Propagation of error, recording of data, protection against outlying data. Experimental designs for calibration. Computer procedures.

Prerequisites: Applicants must have undergraduate college training in engineering or physics and must be currently engaged at a professional level in metrology or calibration. Preparation should include review of "ASTM Manual on Quality Control of Materials" Special Publication 15–C, and "Use of the terms precision and accuracy as applied to measurement of a property of a material" ASTM Designation E 177–61T, American Society for Testing and Materials; E. B. Wilson, *An Introduction to Scientific Research*, ch. 7, 8, and 9; Churchill Eisenhart, *Realistic Evaluation of the Precision and Accuracy of Instrument Calibration Systems, NBS Journal of Research* 67–C, pp. 161–187 (April–June 1963).

Arrangements: Group will be limited to 15 selected on the basis of academic qualification and experience. Fee, $50. Tentative dates: February 14, 15, and 16, 1966. Apply to J. M. Cameron, Applied Mathematics Division, National Bureau of Standards, Washington, D.C., 20234.

High Frequency and Microwave Field Strength (B)

Brief Description: This 3-day seminar will cover topics of interest to those concerned with the measurement of field strength and with antenna standards and their derivation at frequencies from VLF to the microwave regions. Topics will include measurement techniques for calibration of loop, dipole, and horn antennas, antenna gain in field measurements, and calibration of field-strength meters. Emphasis will be on the highly developed techniques in use at the National Bureau of Standards, and on their accuracy limits. Theoretical discussion will be supplemented with laboratory demonstrations.

Prerequisites: Candidates must have college undergraduate level training in engineering or physics or equivalent experience, and must be currently engaged in professional work in antenna or field-strength measurements.

Arrangements: Attendance will be limited to approximately 25 people who will be divided into subgroups for laboratory demonstrations. Fee, $90. Tentative dates: March 7, 8, and 9, 1966. Apply to Harold E. Taggart, High Frequency Calibration Services, National Bureau of Standards, Boulder, Colorado, 80301.

High Frequency and Microwave Noise (B)

Brief Description: This seminar will cover noise standards and their derivation, correlation and switching radiometers, noise sources usable as interlaboratory standards, and noise quantities as applicable in specifications to performance evaluations. Measurements covering a wide frequency range will be considered for both rf and coaxial waveguide systems. The seminar will deal with the techniques developed for use at the National Bureau of Standards, with particular attention to limitations imposed by the effects of mismatch errors and the steps required for their elimination; other sources of error will also be considered. Theoretical discussions will be supplemented with laboratory demonstrations.

Prerequisites: Candidates must have college undergraduate level training in engineering or physics or equivalent experience, and must be engaged currently in precision measurement at a professional level.

Arrangements: Attendance is limited to 25 persons. Fee, $120. Tentative dates: March 1, 2, 3, and 4, 1966. Apply to Charles K. S. Miller, Microwave Calibration Services, National Bureau of Standards, Boulder, Colorado, 80301.

Application Procedure

Laboratory Directors interested in having qualified members of their staff attend any of these seminars should address a letter of application to the appropriate individual listed above.

Since requests for enrollment usually exceed the number of attendees who can be accommodated, application should be made as soon as possible, should give full details of the candidate's qualifications in terms of stated prerequisites, and should be accompanied by check, billing authorization, or purchase order for the stated fee.

Acceptance of qualified applicants, on the basis of first come first served, will be made by letter not later than 4 weeks prior to the tentative date of the seminar. Detailed schedules and housing information will be available at that time, and refund will be made to applicants not accepted. Those accepted will be expected to study the assigned reading material before coming to the seminar, and be prepared to discuss their own experience with related problems.

The suggestions of Laboratory Directors as to topics to be treated in future seminars will be welcomed.

wind velocity, wet- and dry-bulb temperatures (from which relative humidity is determined), and barometric pressure.

Reduction of Data

The variability in apparent path length was first studied by analog spectrum analysis of the magnetic tape data. The radio refractive index was then computed from the simultaneous atmospheric pressure, relative humidity, and temperature readings. The scientists found that the long-term variations in apparent path length are well correlated with the variations in refractive index at the path terminals.

Analysis of the radio refractive index disclosed that daytime variations were greater than nighttime variations by as much as two orders of magnitude. This effect is more pronounced in Florida than in Colorado.

Tower Motion Study

Antennas used in the Florida experiments were mounted on aluminum scaffolding towers. Since the instrumentation was capable of recording apparent changes in path length as small as 0.003 mm, the scientists had to find out how much of the fluctuations observed was due to tower motion and how much to variations in path refractivity. To do this they added a transmitter and receiver operating over a second path extending from an antenna mounted on the tower to a ground-based antenna 30 m away. When the variations in apparent length of the two paths were measured simultaneously, the variations along the second path were found to be smaller by at least an order of magnitude for fluctuation frequencies between 0.01 and 1 Hz. For higher fluctuation frequencies—from 1 to 10 Hz—the variation along the short path was about one-third that along the other. Since most of the short-path variations appeared to be atmospheric in origin, tower movement was discarded as a source of significant short-term errors.

The long-term (hour-to-hour) variations of short paths appeared to be more closely related to tower movements. This was indicated by the fact that the apparent length of the short path showed a low correlation with refractivity, but a high correlation with temperature. This finding suggests that the long-term changes over short paths are due to movements accompanying thermal expansion of the tower members and guy cables. The maximum change in short-path length, however, was only about 1 mm; over the long path this change would cause a discrepancy of only about 1 part in 10^7. Thus tower movements could not have contributed a readable error to measurements of long-term, long-path variations.

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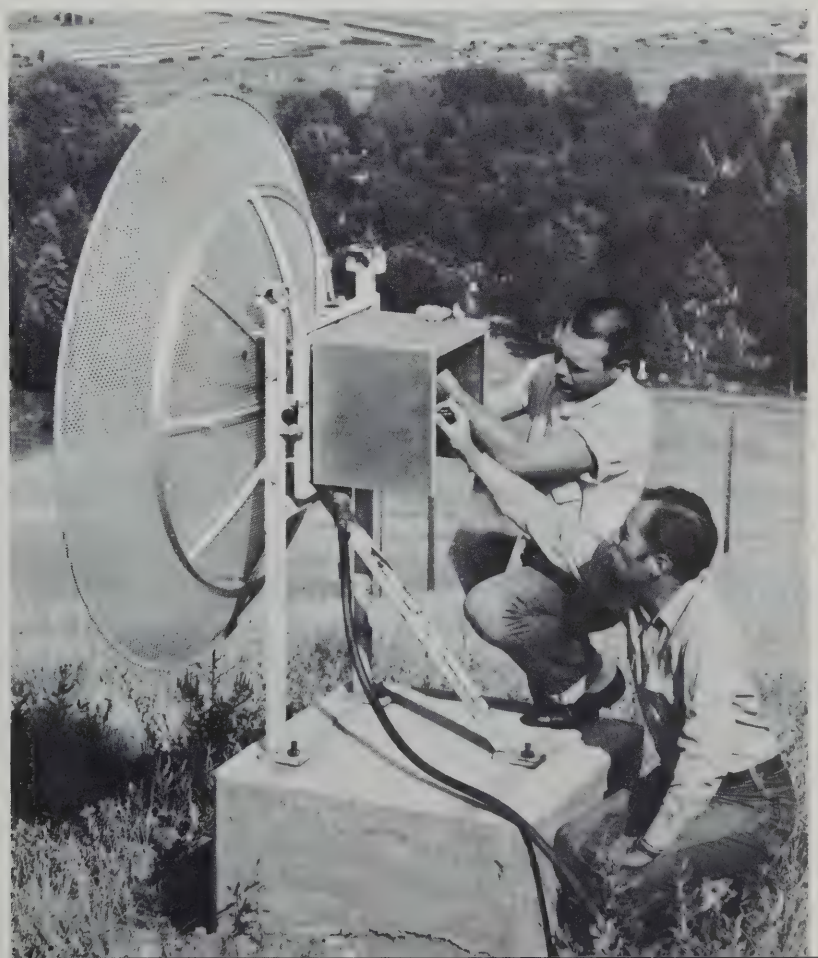
[1] *More technical information can be obtained from NBS Tech Note No. 219,* Radio Path Length Stability of Ground-to-Ground Microwave Links, *by M. C. Thompson, Jr., and H. B. Janes (Nov. 15, 1964).*

[2] CRPL aids missile tracking, *NBS Tech. News Bull.* **46,** *46–47 (March 1962).*

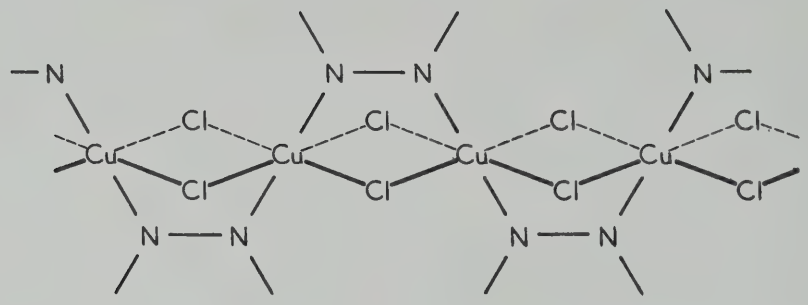
[3] Radio refractometry applied to humidity measurements, *NBS Tech. News Bull.* **47,** *125–126 (July 1963).*



William Grant (on antenna platform) and Donald Waters adjust a dish antenna on Green Mountain, overlooking the Boulder Laboratories.

New Series of

Coordination Compounds of Copper (II) Chloride



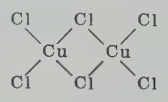
Intramolecular chain bonding in copper (II) chloride-ligand coordination compounds.

★ A NEW SERIES of copper (II) chloride coordination compounds having properties of coordination polymers has been prepared by the NBS Institute for Materials Research. In a study [1] of the structure and energy levels of copper (II) complexes, Institute staff member C. Reimann and NBS Consultant G. Gordon prepared six copper (II) chloride · ligand* compounds.

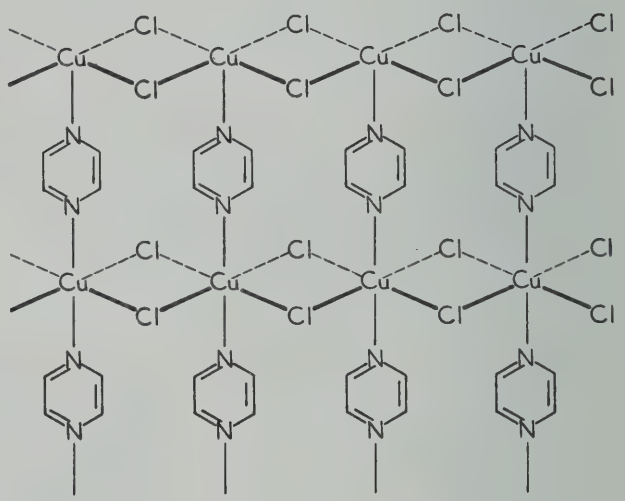
An earlier study [2] of the crystal structure of $CuCl_2$ · 1,2,4 triazole presented the possibility of preparing a variety of $CuCl_2$ · ligand polymers. The NBS scientists believed that they would gain an insight into the structure of this type of copper (II) complex by comparing the properties of several such complexes formed with ligands having two nitrogen donors in different relative positions.

The insoluble, light green compounds were formed by adding excess solid copper (II) chloride dihydrate to six different ligands dissolved in water. The six ligands were: 1,2 diazine (pyridizine); 1,3 diazine (pyramidine); 1,4 diazine (pyrazine); 1,2,4, triazole; 1.10 phenanthroline; and 2,2 bipyridine. The chemical analysis of each compound indicated a chlorine-to-copper ratio of 2: 1 and copper (II) chloride-ligand ratio of 1: 1. The marked similarity of the electronic spectra of the compounds indicated that the nearest neighbors of the copper (II) ions were probably the same.

The model which appears to be most consistent with these facts places copper (II) ions in



chains with the nitrogen atoms of the ligands also attached to copper (II) ions. In terms of this model there are both intra- and intermolecular bonding depending on the nitrogen position within the ligand. Intrabonding ligands have adjacent nitrogens which are attached to the nearest pair of cupric ions of the chain. Interbonding ligands have nonadjacent nitrogens and connect cupric ions of different chains. The



Intermolecular chain bonding in copper (II) chloride-ligand coordination compounds.

low water solubility of the compounds supports the chain-type polymer structure.

In each of the proposed structures, the copper (II) ion has a coordination number of six (bonds with six other ions or atoms), lies at or near the center of four in-plane chloride ions, and has one ligand nitrogen above and another below the plane.

The evidence presented supports the six-fold polymeric coordination of cupric ions. Only a single-crystal x-ray study, however, can elucidate the exact details of these structures. Attempts to grow single crystals of these compounds are, therefore, currently in progress.

**A ligand may be considered as an ion or molecule that is bonded to a metal ion in the formation of a coordination compound.*

[1] *C. Reimann and G. Gordon,* Some new coordination compounds of copper (II) chloride, *Nature,* **205,** *No. 4974, p. 902 (Feb. 1965).*

[2] *J. A. J. Jarvis, Acta Cryst.,* **15,** *964 (1962).*

CRPL Predicts Flare Hazards

★ WHILE THE WORLD watched and listened for news of the Gemini-4 astronauts, the Space Environment Forecasting Division of the NBS Central Radio Propagation Laboratory (CRPL) was keeping an eye on the sun.* Forecasters Dale Bucknam and Roger Olson in cooperation with Constance Warwick were monitoring reports of solar activity to anticipate the possibility of a potentially dangerous solar flare during the flight.

These services rendered to the NASA Mission Control Center in Houston, Tex., provided Trial Solar Advisories during the 4-day flight (June 3–6). Because of the low latitude and relatively low altitude of the Gemini-4 orbit as well as the present low level of the solar activity, there was little chance of dangerous solar particle streams being encountered on this mission. However, the mission did provide a realistic opportunity to test the solar forecasting procedures being developed at CRPL.

The solar advisories issued by the CRPL Boulder Forecast Center in Boulder, Colo., contained information on current solar conditions and forecasts of the likelihood of an important solar flare outburst during the enusing 24-hour period that might produce hazardous solar radiation in the vicinity of the Earth. Forecasts were based on data from cooperating observatories in the United States and around the world.

Predictions like those prepared by CRPL for the Gemini flight will become even more important as manned spacecraft leave the protection of the Earth's magnetic and atmospheric environment. The Space Environment Forecasting Division is investigating whether man can predict the occurrence of a solar flare with reasonable certainty and whether he can distinguish between a flare accompanied by a potentially dangerous solar proton emission and one which is not.

A flare is seen as a sudden brightening of the sun's surface in or near an active region which contains sunspots and other visible forms of activity. A large flare may extend over an area of the sun's surface ranging from 100 million to 1 billion square miles. During the course of these flares, large amounts of additional solar radiation in the form of high energy particles and solar x rays are often emitted into interplanetary space. These radiations present a potential hazard to man's use of the space environment and, in addition, cause a wide variety of effects in the Earth's upper and lower atmosphere and magnetic field.

When a solar flare occurs, it is too late to warn unprotected space travelers against its immediate effects. Those effects will be felt by men in space at essentially the same time as the flare is seen from earth. However, warnings can be provided of the more dangerous delayed effects, especially the arrival of energetic solar protons.

*As this goes to press similar services are being provided for the Gemini-5 flight.

Standard Materials

Publication Series on Standard Reference Materials

To closely link the program of the NBS Office of Standard Reference Materials with research efforts in other laboratories, a publication series entitled "Standard Reference Materials" has been initiated as a medium for broad and rapid dissemination of the results of standard materials investigations at NBS.

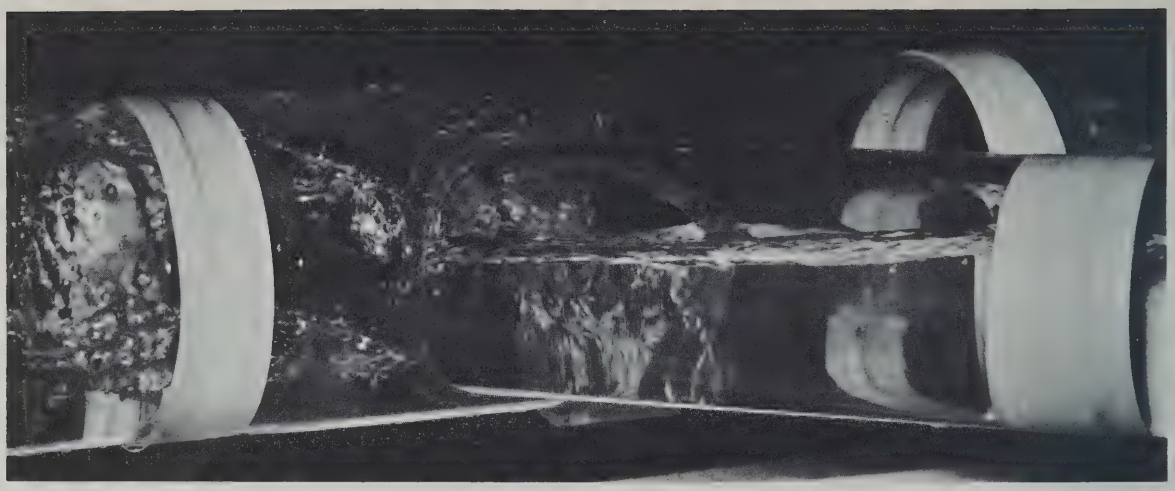
The basic publication in this series, NBS Misc. Publ. 260, is subtitled "Catalog and Price List of Standard Materials Issued by the National Bureau of Standards." This basic section is kept up to date quarterly by issuing supplementary insert sheets as new standards are prepared, old ones are exhausted, renewals issued, and others are discontinued.

Other publications in this series are numbered as Misc. Publ. 260–1, Misc. Publ. 260–2, and so forth. Thus far the following publications have been issued: 260–1, *Preparation of NBS White Cast Iron Spectrochemical Standards;* 260–2, *Preparation of NBS Copper Base Spectrochemical Standards;* 260–3, *Metallographic Characterization of an NBS Spectrometric Low-Alloy Steel Standard;* 260–4, *Standard Reference Materials: Sources of Information;* 260–5, *Accuracy of Solution X-Ray Spectrometric Analysis, of Copper-Base Alloys; and* 260–6, *Methods for the Chemical Analysis of White Cast Iron Standards.* Several more publications in this Series are under way.[1]

Standard Reference Materials Prices Increased

The new catalog of standard reference materials (Misc. Publ. 260) shows an increase in the prices of about half of the samples. In the past, the Bureau has partially supported the standard materials distribution program from funds appropriated for research and development. Because of increasing costs and the current great demands upon NBS resources, it has become necessary to charge users more of the costs of short-term development, related to the reference materials.

[1] *These publications are available from the Superintendent of Documents, Washington, D.C., 20402, for the indicated prices:* 260, 35 cents; 260–1, 30 cents; 260–2, 35 cents; 260–3, 20 cents; 260–4, 20 cents; 260–5, 25 cents; 260–6 (*in press*).



In this compound drain steady flow exists in the main and surge flow in the branch just prior to the production of a full section at the junction.

★ IN A RECENT study at the NBS Institute for Applied Technology the hydraulics of horizontal drains in plumbing systems were investigated. The findings of this study [1] by R. S. Wyly indicate that some drain sizes now specified in some plumbing codes could be reduced without impairing efficiency. Such size reductions would permit the use of less expensive pipes and thus would decrease plumbing costs.

The study provides new criteria, in the form of equations, for the selection of optimum size pipes for horizontal drains in plumbing systems. The equations were derived from measurements of the hydraulic carrying capacities of several experimental systems which were subjected to various types of flow that are characteristic of sanitary drainage systems.

In the past, plumbing code writers, plumbing officials, and design engineers have been handicapped by inadequate data on the hydraulics of plumbing systems. The selection of drain sizes is determined by "fixture-unit" load limits based in part on a knowledge of hydraulic carrying capacities. Incomplete data and the simplifying assumption of steady, uniform flow in the drains has contributed to "overdesigning" (oversized pipes) in some segments of sanitary drainage systems for buildings.

In 1939 an investigation of unsteady or "surge" flow in plumbing systems was conducted at the Bureau. Heretofore unpublished data from this study were used in the preparation of the American Standard National Plumbing Code (ASA A40.8–1955). Since then many codes have been patterned on A40.8. The present study compiled and evaluated the earlier data and extended the research to gain a better understanding of the hydraulics involved in nominally horizontal drains in plumbing systems.

Although the term "horizontal drain" as referred to in plumbing codes includes any drain with a slope of 45° or less, those used in these studies had slopes of $\frac{1}{16}$, $\frac{1}{8}$, or $\frac{1}{4}$ in. per ft. Such slopes are commonly employed in the field. Two types of horizontal drain systems were used in the experimentation. The first type comprised a series of simple drains approximately 100-ft long made of steel, clear plastic, or coated or uncoated cast iron. The other type comprised compound drains made of clear plastic or uncoated cast iron in which a main drain was joined with a branch drain by a conventional 45° branch fitting. The plastic drain permitted visual observation of the flow conditions. The drains had holes drilled in the crown

Surge flow conditions as surge approaches (left), fills drain (center), and begins to empty (right) in a nominally horizontal drain.

New Criteria for PLUMBING SYSTEMS

to indicate a full condition and to simulate the degree of venting that is normally provided by other means in actual plumbing systems.

Three types of flow were investigated: (1) Surge flow in a simple drain, (2) steady flow in a compound drain, and (3) surge flow from a branch into a main carrying a steady flow. The capacity criteria adopted for use in the experimentation did not permit hydrostatic pressure anywhere along the crowns of the drains.

In the first type of flow, the criterion for surge-flow capacity* allowed for the water to completely fill a cross section of the drain.

The capacity criterion for steady flow in the compound system (type 2 flow) allowed for the water to completely fill the cross section of the main at the junction fitting. The criterion for type 3 flow allowed for the water to completely fill the cross section of the main at the junction fitting when the surge from the branch entered the main.

It was recognized that in applying the findings to the design of actual plumbing systems reasonable safety factors should be applied to the experimental values, so as to take into account possible adverse effects of various conditions which may occur in the field but which could not be suitably simulated in the laboratory.

The results show that the surge-flow capacity in a nominally horizontal straight drain exceeded the steady-flow capacity of the same drain by significant amounts. In the compound system, total flow capacity of the system with steady flow in both drains was less than the steady-flow capacity of the main when no flow occurred in the branch. The total flow capacity of the compound system with steady flow in the main and surge flow in the branch was greater than the total flow capacity of the system with steady flow in both drains.

It is thus apparent that criteria based on steady-flow conditions lead to larger pipe sizes than do criteria based on surge-flow conditions for the same volume rates of discharge. Surge flow, or surge flow superimposed on steady flow, is the usual condition in many plumbing systems in buildings. Criteria based on such flow would permit use of smaller pipes where otherwise practicable, thus reducing the system's cost.

For each of the three types of flow an equation was derived to express the flow capacity of the system. The capacities as calculated from these equations compared favorably with experimental data. The equations depend on the type of flow, time duration of surge in the case of surge flow, drain diameter, drain slope, surface roughness, and (in compound systems) on the division of flow between the branch and main. These equations should prove useful to code writers and others in selecting the optimum size pipes for horizontal sanitary drains. A subsequent publication is planned to show one possible application of the equations to the computation of allowable fixture loadings for horizontal fixture branches, building drains, and building sewers.

While the purpose of the study was not related to venting, the results could possibly be utilized in developing an unconventional design of some simple types of horizontal drain systems for one- and two-family houses so as to achieve more economical venting than is customarily provided by conventional methods. However, the present study did not encompass the overall feasibility of such unconventional venting; for this reason further research is needed before the results of this study can be utilized in the design of sanitary drainage systems with unconventional venting.

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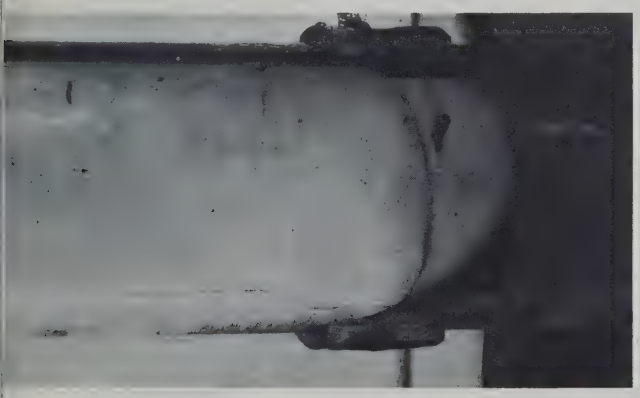
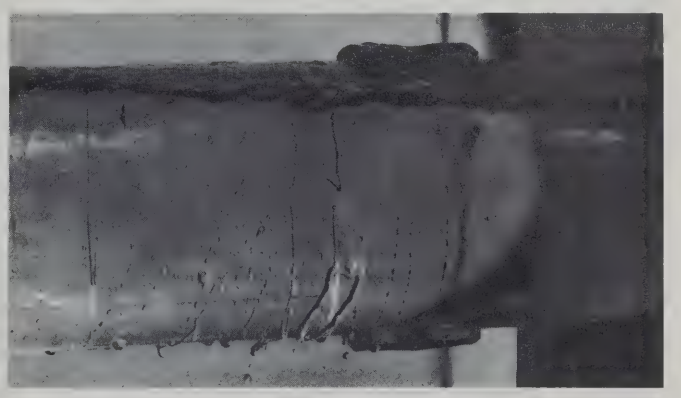
*The term "flow capacity" as used here refers to a volume rate of flow (discharge rate).

[1] *For further information, see* Investigation of the hydraulics of horizontal drains in plumbing systems, *by Robert S. Wyly, NBS Mono. 86 (Dec. 1964) ; and* Capacities of stacks in sanitary drainage systems for buildings, *by R. S. Wyly and H. N. Eaton, NBS Mono. 31 (1961). Both publications are available from the Superintendent of Documents, U.S. Government Printing Office, for 35 cents each. See also* Pipe sizes for plumbing stacks in buildings, *NBS Tech. News Bull.* **45,** *No. 8, p. 140 (Aug. 1961).*



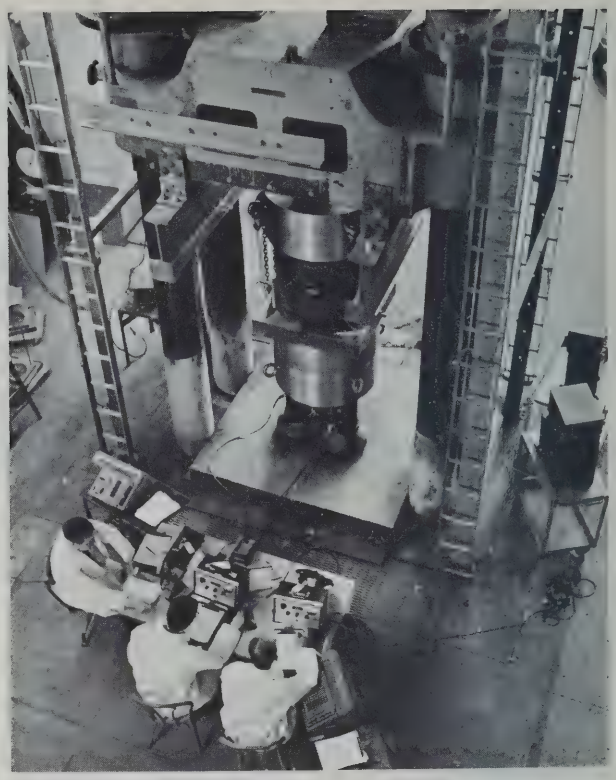


Calibration of

12 Million Pound

Load Cell

A 12,000,000-lb capacity load cell, largest ever produced, is calibrated (at half capacity) against three NBS 3,000,000-lb capacity standard dynamometers. NBS personnel in the foreground are taking readings on calibration indicators. Four 12,000,000-lb capacity load cells were recently calibrated at the NBS Institute for Basic Standards and will be used to monitor the loading of the Saturn V service tower at the "Moonport"—Merritt Island, Fla.—adjacent to Cape Kennedy. The load cells were manufactured by BLH Electronics.



Re-evaluation of Flammable Fabrics Standard

★ THE U.S. DEPARTMENT OF COMMERCE has initiated an industry-government review of standards governing flammable fabrics. The Standing Committee for Commercial Standard CS 191–53, "Flammability of Clothing Textiles," will soon submit a revision of the standard having completed an evaluation of the test procedures and test equipment currently set forth in CS 191–53. The evaluation was made to determine whether the test procedures and test equipment specified are still adequate to protect the public interest in view of market changes and advancing technology. The standard is designed to protect the public against dangerous flammable fabrics.

The Standing Committee on Flammability of Fabrics, recently enlarged to give increased representation to consumer-oriented groups, was originally formed to work on the development of the Commercial Standard, which was published in 1953. The Commercial Standard was included, by reference, in the Flammable Fabrics Act passed by Congress in the same year; and the test procedures defined in the Commercial Standard are used in enforcement of the Act. All coordination of the original work was done by the Commodity Standards Division, then in the Office of Technical Services, and now in the Bureau. Much of the technical work on test methods was done by the Bureau.

The current review will be handled in the same manner as the development of the Commercial Standard, that is, by participation of manufacturers, sellers, and consumers of the products involved.

If, on the basis of the Committee report, the Secretary of Commerce determines that protection of the public interest requires that modifications be made in the Flammable Fabrics Act, he will submit his recommendations to the Congress, as required by law. Any changes in the Act, of course, must be made by the Congress.

PUBLICATION and CONFERENCE Briefs

NOTE: Publications mentioned in this column are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. *Symposium on Thermal Radiation of Solids* (NASA SP–55 or Air Force ML–TDR–64–159), $3.75. *Misc. Publ. 236*, $0.15.

Thermal Radiation Proceedings Available

On March 4–6, 1964, the Symposium on Thermal Radiation of Solids was held in San Francisco, Calif. The proceedings of this meeting, sponsored by the Research and Technology Division of the USAF, the National Aeronautics and Space Administration, and the National Bureau of Standards, have been published by NASA.

The Symposium provided for the presentation and discussion of significant developments in the theory of thermal radiation of solids, and in the understanding of the important effects of surfaces on this radiation. Other matters presented were the effects of the space environment on radiation properties, and the application of this information to the thermal designer's problems. The meeting and the proceedings were divided into four sections along these lines with an additional one on measurement techniques.

The publication includes 55 technical papers edited into a uniform format, with accompanying discussions. A subject index plus one of authors and discussants have been added to aid the reader in his search of the literature. Tables, graphs, and pictures round out the work.

Standard Frequency and Time Services of the National Bureau of Standards

The National Bureau of Standards broadcasts eight technical services in the field of standard frequency and time signals, using four transmitting stations so that the transmissions can be received anywhere in the world. The services include standard radio frequencies, standard audio frequencies, standard musical pitch, standard time intervals, time signals, UT 2 corrections, radio propagation forecasts, and geophysical alerts. These widely used transmissions are available to anyone throughout the world who has the appropriate receiving facilities.

Miscellaneous Publication 236 describes the services and lists the schedules of the broadcasts as of January 1, 1965. In order to provide users with the best possible service, the Bureau will issue occasional changes in the broadcasting schedules. The 1965 edition of Miscellaneous Publication 236 supersedes the editions of 1960 and 1961, and annual revisions are planned.

Symposium on Interdisciplinary Aspects of Radiative Energy Transfer

This symposium on fundamental interdisciplinary aspects of radiative energy transfer is cosponsored by the Office of Naval Research, the Space Sciences Laboratory of the General Electric Co., and the Joint Institute of Laboratory Astrophysics of the University of Colorado and the Bureau. The symposium is scheduled for February 24–26, 1966, in Philadelphia, Pa.

Papers are now being solicited in the following proposed session areas: Space and atmospheric physics, stellar aerodynamics, plasmas, oceanography, atmospheric entry and reentry, and solid transparent media. They will be accepted for final consideration on the basis of titles and abstracts which are to be submitted by October 15, 1965 to:

Mr. James J. Welsh
Program Coordinator, ONR–GE–JILA
Symposium
G.E. Space Sciences Laboratory
Box 8555
Philadelphia, Pa. 19101

High Pulse Voltage and Microwave High-Power Seminars

Two seminars related to the measurement of high pulse voltage (100 kV and above) and microwave high power (100 kW average and greater) were held at the Bureau on April 14 and 15, 1965. The first session, conducted by F. R. Kotter (NBS), was devoted to high pulse voltage measurements; the second session, conducted by E. C. Wolzien (NBS), considered the subject of microwave high power. The purpose of these meetings was to identify the areas in which future work by NBS would be most valuable to industry, to recommend methods of high pulse voltage and microwave high-power measurement which should be proposed for adoption in military specifications of microwave high-power tubes, and to provide conference participants with an opportunity for a general exchange of information.

The two meetings were sponsored by the Bureau and arranged with the joint participation of the JT–13 Committee on Microwave Devices. This Committee is part of the Electron Tube Council which in turn is a part of the Joint Electron Device Engineering Council (JEDEC) of the Electronic Industries Association (EIA) and the National Electrical Manufacturers Association (NEMA).

NBS presently provides a calibration service up to 100 kV at a pulse width of 12.5μsec for voltage dividers.[1] Industry would like to see this service extended up to at least 300 kV and in this same range expanded to measure narrower pulses. In addition, it would like to have NBS look into the errors of measurement and methods of use associated with capacity

dividers and with resistive dividers having shaped shields. The seminar also brought forth the recommendation that the JT–13 committee prepare material on these voltage dividers for military specification proposals.

Conference discussions held on the first day focused attention on the need for accurate pulse-voltage measurements to insure product uniformity by manufacturers and interchangeability of their tubes. Improved pulse-voltage measurements would also permit more accurate measurements of tube perveance, an essential design parameter which is determined from the cathode current and the anode voltage. A need to measure characteristics of the shape of the high-voltage pulse was also mentioned.

At the seminar on microwave power, the necessity for better measurement of power output and high-power tube efficiency was pointed out. For example, microwave-power measurements are essential for telemetering systems and for radar systems. The seminar also considered specific problems in power measurement: Power losses through tube windows, fluctuation of the efficiency factor of tubes with frequency, the measurement of the harmonic component of the power, and the occurrence of steam, which may degrade the temperature measurement, in a calorimeter measurement of power.

NBS presently does not provide a calibration service for microwave high-power measurements. NBS studies requested by the conference participants include a broad program on power splitters, particularly directional couplers, and an error analysis of the flow calorimeter method of power determination. Participants from industry at both seminars stressed the importance of a wide dissemination of information by NBS on its methods of high pulse voltage and microwave high-power measurement. Such dissemination would tend to increase the uniformity of measurements made by tube manufacturers and users.

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[1] New calibration service: ratio factor of pulse voltage dividers, *NBS Tech. News Bull.* **49**, *81 (1965)*.

Publications of the National Bureau of Standards

Periodicals

Technical News Bulletin, Volume **49**, No. 8, August 1965. 15 cents. Annual subscription: $1.50. 75 cents additional for foreign mailing. Available on a 1-, 2-, or 3-year subscription basis.

CRPL Ionospheric Predictions for November 1965. Three months in advance. Number 32, issued August 1965. 25 cents. Annual subscription: $2.50, 75 cents additional for foreign mailing. Available on a 1-, 2-, or 3-year subscription basis.

Journal of Research of the National Bureau of Standards

Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, $4; foreign, $4.75. Single copy, 70 cents.

Section B. Mathematics and Mathematical Physics. Issued quarterly. Annual subscription: Domestic, $2.25; foreign, $2.75. Single copy, 75 cents.

Section C. Engineering and Instrumentation. Issued quarterly. Annual subscription: Domestic, $2.25; foreign, $2.75. Single copy, 75 cents.

Section D. Radio Science. Issued monthly. Annual subscription: Domestic, $9; foreign, $11.50. Single copy, $1.00.

Current Issues of the Journal of Research

J. Res. NBS **69A** *(Phys. and Chem.), No. 5 (Sept.–Oct. 1965).*

Current research on preservation of archival records on silver-gelatin type microfilm in roll form. C. S. McCamy and C. I. Pope.

Franck-Condon factors to high quantum numbers VI: C_2 band systems. R. W. Nicholls.

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Heat of formation of calcium aluminate tricarbonate at 25 °C. H. A. Berman.

Vapor pressure and heat of sublimation of tungsten. R. Szwarc, E. R. Plante, and J. J. Diamond.

Heat capacity and enthalpy measurements on aluminum carbide (Al_4C_3) from 15 to 1173 °K. Thermodynamic properties from 0 to 2000 °K. G. T. Furukawa, T. B. Douglas, W. G. Saba, and A. C. Victor.

Properties of aqueous mixtures of pure salts: thermodynamics of the ternary system water-potassium chloride-barium chloride at 25 °C. R. A. Robinson and V. E. Bower.

A wide-range (up to 10^{10} P) rotating cylinder viscometer. A Napolitano, P. B. Macedo, and E. G. Hawkins.

Internal friction in ZrO_2 containing CaO. J. B. Wachtman, Jr., and W. C. Corwin.

Splitting of equivalent points in noncentrosymmetric space groups into subsets under homogeneous stress. H. S. Peiser, J. B. Wachtman, Jr., F. A. Munley, and L. C. McCleary.

Inclusion of perfluoromethyl groups in the lattice of copolymers of tetrafluoroethylene and hexafluoropropylene. L. H. Bolz and R. K. Eby.

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Ground-based passive probing using the microwave spectrum of oxygen. E. R. Westwater.

Response of NBS microwave refractometer cavities to atmospheric variations. R. O. Gilmer, R. E. McGavin, and B. R. Bean.

Effects of rocket outgassing on rf experiments. W. Pfister and J. C. Ulwick.

Further analysis of propagation of plasma waves in a "spoke-wheel" magnetic field. R. R. Gold.

Measurement of group velocity of 17.8-kHz VLF radio waves. W. D. Westfall.

On the radio noise level at low and very low frequencies in polar regions. T. S. Jørgensen.

Experimental study on the circular loop antenna immersed shallowly in a conducting medium. K. Iizuka.

Directivity of uniformly spaced optimum endfire arrays with equal sidelobes. M. T. Ma.

Extension of Fock theory for currents in the penumbra region. V. H. Weston.

Isometric-circle interpretation of bilinear transformation and its application to VSWR minimization. J. G. Rudolph and D. K. Cheng.

Magneto-ionic propagation in inhomogeneous media. Part I. Transverse propagation. B. K. Banerjea.

Magneto-ionic propagation in inhomogeneous media. Part II. Oblique propagation. B. K. Banerjea.

Editorial comment on the scientific papers of Lord Rayleigh (John William Strutt). J. R. Wait.

Other NBS Publications

Grading of abrasive grain for grinding, CS271–65 (April 12, 1965). Supersedes SPR R118–50.

Publications in Other Journals

This column lists all publications by the NBS staff, as soon after issuance as practical. For completeness, earlier references not previously reported may be included from time to time.

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Publications for which a price is indicated are available by purchase from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402 (foreign postage, one-fourth additional). Reprints from outside journals and the NBS Journal of Research may often be obtained directly from the authors.

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